Longitudinal Comparative Study: Females' vs. Males' Graduation Outcomes in Undergraduate Engineering

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Abstract
Increasing post-secondary enrolments, reducing university-drop-outs, while, simultaneously, boosting graduation-rates, is a worldwide-dilemma, currently challenging any-university and any-educational-system. One of the most-pressing-issues facing universities, however, is the number of students, who fail to graduate. The literature-survey on gender-differences in scholastic-performance indicates mixed-results. The outcome of ''degrees awarded'' is a commonly-used-indicator in assessing the efficacy and effectiveness of engineering-programs. This-study conducted a comparative-examination of undergraduate "degrees awarded" to females and males, for the period between 2003 and 2014, over five-undergraduate engineering-programs at School of Engineering (SOE), Moi University (MU). The analysis is based not only on graduation-numbers, but on deeper-differentiation in terms of six-types of graduation-outcomes (degree-classification). In addition, the study attempted to determine whether there are significant-gender- differences in graduation-types and rates, among undergraduate-students at SOE, MU. This-study also reviewed the individual-and institutional-level-factors, that jointly predict students' likelihood of completing a bachelor's degree in engineering. This-article is an account from a larger gender-related-study based on SOE, MU. Major-finding of the-study is that, female-undergraduate engineering-students performed as well as, and in some-instances, even better, than their-male-counterparts. The study recommended several-areas for further-research, as well as, specific-recommendations (departmental and school-level) as to how to increase graduation-rates.
Keywords: graduation rates, degrees awarded, females, undergraduate, engineering education.

1. Introduction

1.1. Phenomenon of underrepresentation of females in engineering education.

Since the early 1970s, worldwide, the under-representation of women, in scientific and engineering- education and careers, has been considered a critical-issue for at least two-reasons: (1) the potential- contribution of women to the size, creativity, and diversity of the scientific and engineering-workforce, and (2) the principle of social-equity, expressed in the belief that scientific-careers should be ''open to talent,'' and not governed, or constrained by personal-factors, such as race and gender (Besterfield-Sacre, 1997; Long& Fox, 1995; Pearson& Fechter, 1994; Merton, 1973). Despite significant-efforts to boost female enrolment-levels and retention-rates in engineering-programs, females continue to make up only a small portion of the undergraduate-engineering student-population (Linda& Creighton, 2015; Mapuranga *et.al,* 2015; Hughes, 2013; Gordon, 2007; Bybee & Starkweather, 2006; Boskerb & Dekkers, 2006; NSB, 2006; Lotkowski, 2004; Ernest, 2003; Plonski & Saidel, 2001; Roger &Duffield, 2000). Country-level-studies have been done by Nyamu (2004); Nungu (1994); Onsongo (2007) and Onsongo (2008) among others.

Increasing post-secondary-enrolments, reducing university-drop-outs, while simultaneously-boosting graduation-rates, is a worldwide-dilemma currently-challenging any-university and any-educational-system. Attracting young-women to engineering-programs is not the only-challenge. Engineering-schools need to now understand why women lose their-academic-confidence and leave the engineering-profession, once they have entered it.

University-education plays a critical-role in building a strong STEM-workforce, for the future. The Kenyan university-education-system, however, frequently loses many-potential engineering-graduates due to drop-outs. Recent-study of Starovoytova & Cherotich (2016a) revealed that female' undergraduate admissions rates at MU (the second-largest public-university of Kenya) was found on average at 45.4%. Over the past-twelve-years, gender-representation in SOE, MU has remained relatively-unchanged, with females making up on average only 13.9% of all-engineering-students. The withdrawal- rate (students who were admitted to engineering, but did not graduate in engineering) was found at 30%, while total-retention rate, SOE (2003-2014) was found to be 0.9 (10% drop-out in graduates). The overall-enrolment and graduation-pattern in SOE, MU programs, within the span of 12 years, revealed that female-enrolment and graduation was significantly lower, than that of males. This trend suggests that females' participation in engineering-professions is likely to be affected. Moreover, according to Starovoytova *et al.* (2015) the proportion of the practicing engineers in Kenya has a deficit of - 216%.The data, presented in both-studies, raised serious-questions about the future of Kenya's engineering, as the nation needs extra well-prepared and gender-balanced engineering-workforce; currently, however, the supply is devastatingly-smaller than the ever-increasing demand.

1.2. Graduation rates as measurement of success of engineering programs and factors affecting the rate of success (statement of the problem and justification of the research)

One of the most-pressing-issues facing universities is the number of students, who fail to graduate. Nearly one out of five, four-year-institutions graduate fewer, than one-third of its first-time, full-time degree-seeking first-year students within-six- years (Carey, 2004). Although there are various-explanations for attrition, students often leave for personal-reasons, job-demands, dissatisfaction with the academic- environment, and incongruence with campus-values (Kuh *et. al.,* 2005). Low-graduation-rates: (a) cost universities scarce-resources; (b) weaken the ability to meet educational-objectives; and (c) reflect the university's inability to meet the educational, social, and emotional-needs of students (Mangold *et. al.,* 2002).

One-way, through which quality and overall-effectiveness of higher-educational-institutions are measured, is by student-outcomes, such as student-retention, attrition, and graduation-rates (Schreiner, 2009; Wintre & Bowers, 2007). The outcome of ''degrees awarded'' has conceptual and practical-validity. The indicator has been endorsed by evaluation-studies, assessing the efficacy and effectiveness of women in engineering-programs (Brainard *et al.,* 1993). Correspondingly, for continued-administrative-support by the universities, in which they are located, programs often need to reference "degrees awarded to women". Although alternate-definitions of "success" exist (Walsh, 2000), the particular-measure of degrees awarded to women is organizationally-significant, in the higher-education-settings of programs for women in science and engineering.

The focus upon women, at the undergraduate-level, in particular, is critical to understanding and improving gender-equity in science and engineering for two-related-reasons. First, in order to pursue advanced-education in science and engineering, one usually needs to have had undergraduate-preparation in these-fields (Hanson, 1996). Second, the undergraduate-level of education is acknowledged to be the ''latest point'' for a standard-entry into science and engineering-professional-fields (Xie& Shauman, 2003).

The literature-survey, on gender-differences in scholastic-performance, at different-levels, indicate mixed-results. Books and articles, published in the 1970s and early 1980s, suggested that males are inherently-superior in certain-mathematical-reasoning and visual-spatial-abilities (Benbow& Stanley, 1980; Maccoby & Jacklin, 1974). These-writings, which continue to receive widespread-publicity, may have discouraged many-females from even thinking about entering scientific and engineering-fields (Brush, 1991). More-recent-studies, however, have shown that some of the alleged-ability-differences disappear under more-careful-analysis, others are attributable to gender-bias in standard aptitude and achievement tests, while others result from differences in experience (Friedman, 1989; Linn& Hyde, 1989; Marsh, 1989). More-disturbing than these-questionable ability-differences, however, are commonly observed differences in self-confidence. Latest-studies, on the-other-hand, revealed one-common finding, is that females, apparently, outperform their-male counterparts, in higher-education (Fox, 2011; Franzway, 2009; Brtner, 2005).

Several-previous-studies have identified many of the obstacles women face in attaining their-degrees (can be broadly grouped into societal/cultural barriers, and institutional barriers) (Starovoytova & Cherotich, 2016a; CHE, 2013; Asmussen, 2010; Letseka & Maile, 2008). The studies documented the resulting-degradation in performance, attitude and confidence, and made recommendations of corrective actions to remedy the situation. The effects of race, gender and poverty, among other socio-economic- variables, on student drop-out or graduation, from a higher-education-institution, have been well- documented in recent-literature (CHE, 2013; Asmussen, 2010).

To address the above-issues, this-study, therefore, conducted a comparative-examination of undergraduate-degrees-awarded, to females and males, for the period between 2003 and 2014, over five undergraduate-engineering-programs at SOE, MU. The analysis is based not only on graduation-numbers, but on deeper-differentiation, in terms of six-types of graduation-outcomes (e.g. degree-classification). In addition, the study attempts to determine, whether there are significant-gender-differences in graduation- types and rates among undergraduate-students at SOE, MU. This-study also reviews the individual-and institutional-level factors, which jointly predict students' likelihood of completing a bachelor's degree in engineering. The-study is significant, because it adds to the existing-body of knowledge, that examines comparatively low-female-graduation-rates in engineering and technology-education. Additionally, as a result of the study, the researchers anticipate encouraging gender-equity in engineering and technology- education-programs across Kenya, and, abroad, that will attract and retain students of both-genders. The primary-audiences for this-article are those-policy-makers, legislators, educational-leaders, and educational and scientific-organizations, who work to enhance the preparation and diversity of Kenya's future-engineers.

2. Materials and methods

The study was conducted at the SOE, MU, Eldoret, Kenya. Kenya is one of the developing-countries in the African-region, which has a well-established education-system. The Quality of Education system of Kenya is ranked high, being 37 out of 144 (Global Competitiveness Report, 2012–2013). Kenyan-students have equal access to education, from nursery-education to higher-school-education. For detailed-background information on

Kenya and its university-education (see Starovoytova, 2015).

2.1. Relevant background information

The formal-education-system in Kenya is so-called "8-4-4" system, includes 8 years of compulsory and free-basic-primary-education, 4 years secondary-education and 4years (min) of higher-education institutions. Kenya has more than 3,500 secondary-schools, with some 700,000 pupils. Most-pupils are 14 years old, when they start secondary-education. Less than 50 per cent of primary-school pupils continue on to secondary-education.

In Kenya, in the third-year of studies at the secondary-school (form 3), students choose to study at least two-science subjects from Biology, Physics and Chemistry, and are later assessed, at the end of the fourth year, by the Kenya Certificate of Secondary Education (KCSE) examination.

Seven-examinable-subjects are required, and they must include English, Kiswahili and Mathematics. The rest should be chosen from other-groups. The curriculum is made up of subjects divided into five groups: *Group 1:* English, Mathematics and Kiswahili; *Group 2:* Biology, Physics, Chemistry, Physical education and Biological-sciences; *Group 3:* History and government, Geography, Christianity, Islam, Social-studies and ethics, and Hindu-Islamic-Education; *Group 4:* Home-science, Art and design, Agriculture, Woodwork, Metalwork, Construction, Power-mechanics, Electricity, Drawing and design, and Aviation-technology; *Group 5:* French, German, Arabic, Music, Commerce, Economics, Typing and office practice.

The subjects in group 1 are compulsory, for all pupils. In addition, they must also choose at least-two subjects from group 2, and can choose, freely, from the other-groups. The subjects offered will depend on individual-schools and what they can offer in terms of learning and teaching-resources.

Whereas the qualification for entry to university was set at C+, the limited-university-vacancies causes many-qualified-students to stay away from university, or join self-sponsored programs (PSSP), private universities or middle-level-colleges. Thus, there is relatively low-access to education and training, at this level.

Unlike many Western-countries, where potential-students apply directly to the universities and colleges of their choice, applicants in Kenya apply through a central body, called Kenya Universities and Colleges Central Placement Service (KUCCPS), (the body that replaced the Joint Admissions Board - JAB). KUCCPS oversees all students' admissions to all-public-universities. Prospective-students apply to KUCCPS with an opportunity to choose at most two-programs of study and two-Universities. Each university sets its KUCCPS admission-score on a competitive-basis, which makes such cut-off point to vary from one-university to another. KUCCPS has been lowering the cut-off-points for university entry for females by one-point (according to the affirmative-action to attract more-females to engineering).

MU is the second-public-university to be established in Kenya, after the University of Nairobi. The SOE is one of 13 schools within MU; it has accredited programs in Chemical & Process Engineering (CPE), Civil & Structural Engineering (CVS), Electrical & Communications Engineering (ECE), Mechanical & Production Engineering (MPE) and Manufacturing, Industrial & Textile Engineering (MIT). All the engineering-programs have integrated Privately-Sponsored Student Programs (PSSP) with the Government Sponsored Students Programs (GSSP) (MU official website, 2015).

The University's undergraduate-grading-system is as follows: 100-70 (A), 69-60 (B), 59-50 (C), 49-40 (D), and below 40 (E-fail). SOE, MU undergraduate-engineering graduation-outcome spectrum is based on degree-classification system, as follows: *1st class honors*: weighted average mean for 5 years (1st year-5%, 2nd year- 20%, 3, 4&5 years @25% each) is 70 and above; *2nd class honors upper division*: weighted average mean for 5 years is 69-60; *2nd class upper division*: weighted average mean for 5 years is 69-60, however a student have repeated one or several years of study, therefore cannot be awarded honors degree; *2nd class honors lower division*: weighted average mean for 5 years is 59-50; *2nd class lower division*: weighted average mean for 5 years is 59-50, and *Pass:* weighted average mean for 5 years is 49-40.

Students are allowed to transfer to other-schools or departments, within MU, they can also repeat a year, based on an academic ground, and they can also defer their-study, based on any of medical, financial, or compassionate-grounds. While the repeat of the academic-year can be authorized only once per the same academic-year, currently at MU there is no-policy on deferment of studies, meaning, that student can defer for one year, come back and defer again, and again, and so on.

During data-collection, authors faced several-difficulties, namely: absence and or fragmentation of records and in some-cases unwillingness of the administrative-staff, first to locate and then, to deal with old-archives. In addition, in many-cases, even if the data was available, it was not gender-segregated. Inadequate-gender-segregated-data covering not only enrolment, graduation, but the most-importantly progression from year to year, reasons for repeat, drop-out and deferral of studies, affected data examination of SOE females' retention.

2.1. Methodology of the study

Two-primary-goals for this-study are: (1) comparative-examination of undergraduate-degrees-awarded to females and males, over five-undergraduate engineering-programs at SOE, MU and (2) review of the individual- and institutional-level factors, which jointly predict students' likelihood of completing a bachelor's degree in

engineering.

The analysis is based not only on graduation-numbers, but on deeper-differentiation, in terms of different types of graduation-outcomes (degree-classification). In addition, the study attempts to determine whether there are significant-gender-differences in graduation-types and rates, among undergraduate students at SOE, MU. The study used a comprehensive, quantitative, institutional, and longitudinal-method to achieve its objectives. In particular, longitudinal-institutional-data in the assessment of "success" - five-year graduation-outcomes (degrees-awarded), where the retrospective-data is limited to the period between 2003 and 2014. For the subject period, 3368 students were admitted to SOE, while 2358 students graduated (giving approximately 30% withdrawal- rate (students, who were admitted to engineering, but did not graduate in engineering), while calculation of the retention-rate revealed it to be 0.9. The vast-majority of students in our-sample was male; only on average 13.9% were female.

SOE enrolment-register, university-administrative-reports, graduation-almanacs and MU Senate records, among others, were examined throughout the data-collection-process. To draw inferences from the collected retrospective-primary-data, the statistics was coded, summarized, interpreted and analyzed by SPSS software.

After weighting the data, the cases with missing values were addressed by using multiple imputations. Missing data provide a source of variation (Sinharay *et al.,* 2001), and providing a single-imputation for missing values does not account for this-possible-variance. Little& Rubin (2002) suggest, that multiple imputation provides a more-precise-estimate of standard-errors of parameter estimates. The multivariate normal-approach available in STATA 11, to execute the multiple-imputation-procedure, was used. DeAngelo *et al.* (2011), provide additional-details about the multiple-imputation-procedure. Thereafter, the data was examined with univariate-descriptive-statistics. Odds ratios (OR), after adjusting for cohort-effect and 95% confidence-intervals (CI) are used as indicators of the strength of association. A p-value less than 0.05 is considered as statistically-significant, throughout the study. Graduation Female to total-number of students- graduates ration was calculated, per department and overall for SOE. To review the barriers, critical analysis of secondary-sources of information was used.

3. Results

3.1 Comparative Degree classification per department.

The results of comparison of total number of males' and females' graduation-outcomes (6 types) presented per department and shown in Figure 1, 2, 3, 4, and 5; while Figue 6 shows the total-number of students graduated per degree of classification and % of females, graduated at SOE, for the subject-period. Figure 7 shows % of Females per degree-classification, while Figure 8 illustates the same for males.

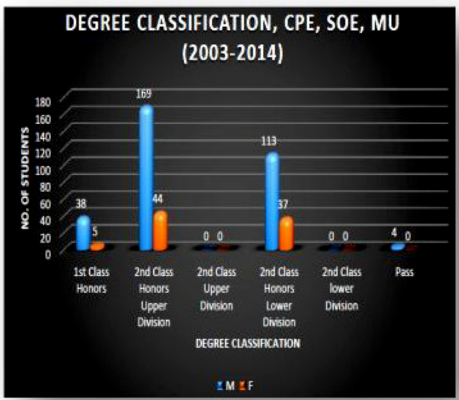


Fig.1: Degree classification, CPE

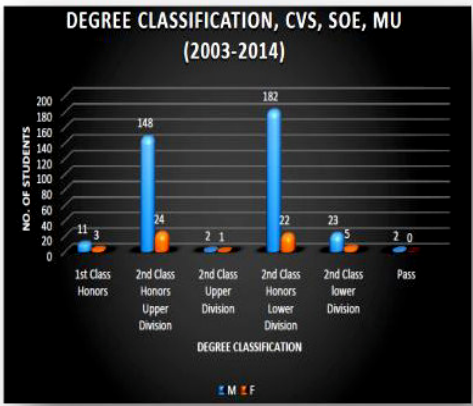
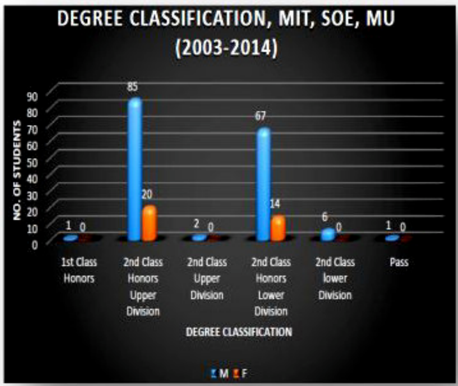


Fig.2: Degree classification, CVS



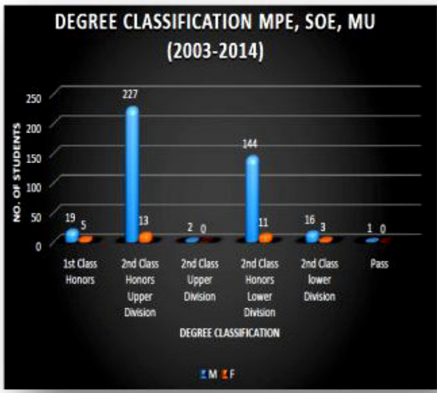
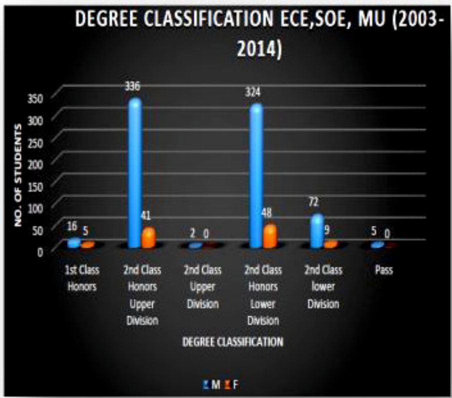


Fig.3: Degree classification, MIT

Fig.4: Degree classification, MPE



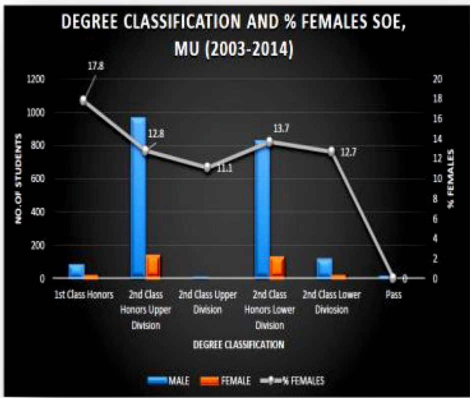
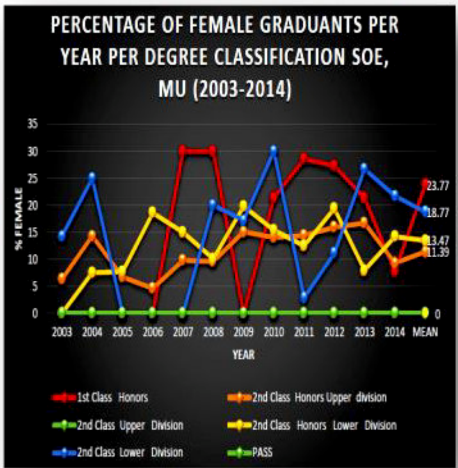


Fig.5: Degree classification, ELC

Fig.6: Degree classification and % females, SOE



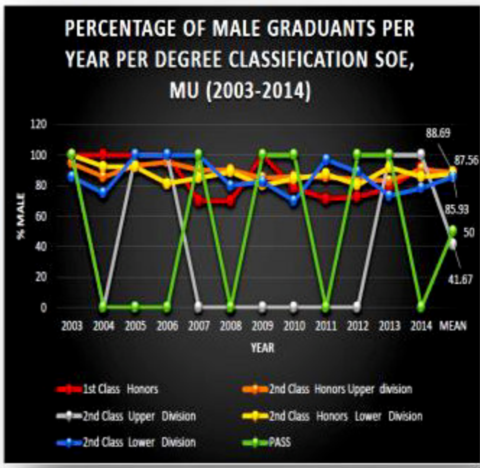


Fig.7: Female% per degree classification

Fig.8: Male% per degree classification

From the statistics of graduants, per department, SOE (over the subject-period) the ration of total number of females to the total-number, was calculated; and the results are as follows: CPE-1:4; CVS-1:6; MPE-1:11; MIT-1:4; and ECE-1:8.

4. Discussions

4.1. Analysis of graduation statistics

The following is the gender-segregated-analysis of the-degrees-awarded (separated into 6-types of degree

classification) for the period between 2003 and 2014, across five-departments at SOE, MU.

CPE: The highest-number of females (44) graduated with Second class honors upper division, followed closely by the number of female-students (37) graduated with Second class honors lower division. 5 female students graduated with First class honors. Neither male no female student graduated with Second class upper division and Second class lower division, meaning that none of the grandaunts of CPE were repeaters. Also none of females of CPE, in contrast with males, graduated with Pass.

CSE: The highest-number of females (24) graduated with Second class honors upper division, followed closely by the number of female students (22) graduated with Second class honors lower division. 3 female students graduated with First class honors. 5 female students graduated with Second class lower division, while 1 female student graduated with Second class upper division. Also none of females of CSE, in contrast with males, graduated with Pass.

MIT: The females, of this- department, graduated only in 2 categories; the highest number of females (20) graduated with Second class honors upper division, followed closely the number of female students (14) graduated with Second class honors lower division.

MPE: The highest-number of females (13) graduated with Second class honors upper division, followed closely the number of female students (11) graduated with Second class honors lower division. 5 female-students graduated with First class honors. 3 female students graduated with Second class lower division, while none of the female students, in contrast with males, graduated with Second class upper division and Pass.

ECE: The highest-number of females (48) graduated with Second class honors lower division, followed closely by the number of female students (41) graduated with Second class honors upper division. 9 female students graduated with Second class lower division. 5 female students graduated with First class honors, while 1 female student graduated with Second class upper division. Also none of females of ECE, in contrast with males, graduated with Pass and Second class upper division.

The above-statistics reflect only actual-numbers of students; however it does not reflect the share of female-students in total-number of students, graduated in the SOE, in the same-graduation-category. Thus, the same could be presented as follows: The highest-share of female students (17.8%) graduated with First class honors, followed by 13.7% of females graduated with Second class honors Lower division, followed by 12.8% and 12.7% graduated with Second class honors upper division and Second class Lower division respectively.

From the analysis, it is also evident, that for the subject-period, two-departments CPE and ECE graduated the highest-number of females, each of 96, followed by CSE with 60, then MIT with 48, and the lowest number 36 graduated from MPE. On average for the SOE, the ration of female to total number of students-graduates is 1:7, meaning that, for every 7 students, graduated from SOE, there was only one female. Some departments appear to be more-masculine, than the others; for example MPE, where for every 11 students graduated, there was only one female. MIT and CPE appear to be less-masculine than all the other-departments, as for every 4 students graduated from any of the two-departments, there was one female.

From the above comparisons, it is evident, that female-undergraduate engineering-students performed as well as, and in some instances, even better, than their male-counterparts. This is in line with the previous studies, e.g. Chen *et. al.* (1999), reported that the female-students in their-study performed better in all classes, but one. Turut-Asik &Dayioglu (2006), found that a smaller-number of female students apply for university-admission. Once they get admission, they work-hard to earn better-grades, than their-counterpart male-students. Snyder *et al.* (2008), stated that males completed college at lower rates, than females and those males fell behind even after they had decided to obtain college-diploma.

Figure 7 and Figure 8 show % of graduates (females and males, respectively) per every year of the subject-period. The analysis established, that there is no-predetermined trend/pattern in the data, neither in females' graduation-rates, no in the-graduation rates of males; however the study confirms that two statistics are significantly-different ($p \leq 0.05$).

The gender-differences in scholastic-performance, as well as the basis of such-differences, have been studied extensively, by many-researches, worldwide. The following multi-faced-summary is a reflection of extensive and critical-review of secondary-sources of information. The review recorded below does not claim to be a fully comprehensive-account of every-instance, associated with the issues shaping success or failure in university-education, but it does give a fairly-good-picture of the fundamental-distinction and nature of the issues, and , probably, include the most-significant-ones identified, for which information was available, at the time this-study was carried-out.

4.2. High school academic performance and the nature of gender differences.

An important-aspect of the argument, with respect to the state of females in engineering, is the issue of differences between the genders. The existence of differences is generally-accepted; however, it is the origin of such-differences that puzzles researches, and currently makes up an important-mass of academic- research and debate. While some-researchers attribute the differences to societal-factors, others maintain that society is simply

reinforcing differences, that are originally-biological. Other researchers still, view that both biological and social-factors affect assumed-differences between the genders. Various-researchers pointed to biological-differences, as the origin of and most-credible-explanation of the differences between the sexes (Barnard, 2012; Adelman, 2006). Evolutionary-social-psychologists, however, believe that males and females are similar, or, the same, in areas where they faced the same-adaptive-problems, but different in domains, where they had different-sets of adaptive-problems to solve.

4.3. Issues shaping success or failure in university education

Admitting students to universities implies that the students are capable of successfully completing the programs, in which they are permitted to enroll. Fraser& Killen (2003) observe that, "To knowingly admit students who, for whatever reason, have no chance of academic success would be immoral. Therefore, it is necessary to have entry-requirements, which permit valid-student-selection-decisions to be made". The practice of using high-school-results as the principal-determinant for university-entrance, is common in many-countries, including Kenya. Although there is research-support for this-practice (e.g. McKenzie &Schweitzer, 2001), the ability of these-techniques to predict student-success has been rather limited (Graham, 1991; Riggs& Riggs, 1990). Manning *et. al.* (1993), implies that "selection of cut-off points is more related to supply and demand, than it is to predictive-validity in terms of potential-success". Similar conclusions about the limited-predictive-value of school-academic-performance were also established by Larose& Roy (1991), Johnes (1990), and Chase & Jacobs (1989). Some-educators argue that entry-standards are the most important-determinants of successful-completion of a university-program; others maintain that non-academic-factors must also be considered.

In Kenya, in fact, it would turn to the assumption that high school learners, who have achieved a certain-number of points in their KSCE results will succeed at university. Experience has however, shown that there is no-guarantee, that these-students will eventually satisfy the requirements for graduation.

Setting appropriate-goals, a good-study-environment, and effective-time-management were considered important, in order to succeed in university-studies. Academic-failure was attributed primarily to lack of study, poor-time-management, and inadequate-goal-setting. Student self-efficacy also features prominently in attempts to explain student-success (McKenzie &Schweitzer, 2001; Kleemann, 1994). It is therefore, argued that single-measures per se, like previous-academic-success, is not a strong-predictor of success at university. Multiple-measures, used in combination, can be more-predictive, than each of the measures, used individually (Solomon *et. al.,* 1989).

For example, Killen (1994) concluded, that some of the most-significant-factors in students' academic success at university were interest in the course, motivation, self-discipline and effort (none of which can be predicted-directly from high-school-results). Student-effort was also prominent in students' explanations of success and failure in a study by Schmelzer *et. al.* (1987). They found, that persistent and active-study was the most-common-reason that college students gave for their-academic-success.

The following-closer-look at complex-issue of forecasting of academic-success is, therefore, valuable to the comprehension of the subject-matter.

4.3.1. Bronfenbrenner's theory of human ecology

In order to better understand the influence of institutional-contexts on engineering-degree-completion, this study is following Bronfenbrenner's (1979) Theory of Human Ecology. The theory organizes a person's environment into a series of nested-systems, in which people interact, namely: Microsystems, Mesosystems, and Microsystems (see Figure 9). A university-environment was conceptualized as a nested-series of Microsystems, Mesosystems, and Microsystems. Factors of interest were identified, within each of the arrangement, to examine how they may affect engineering-degree-completion.

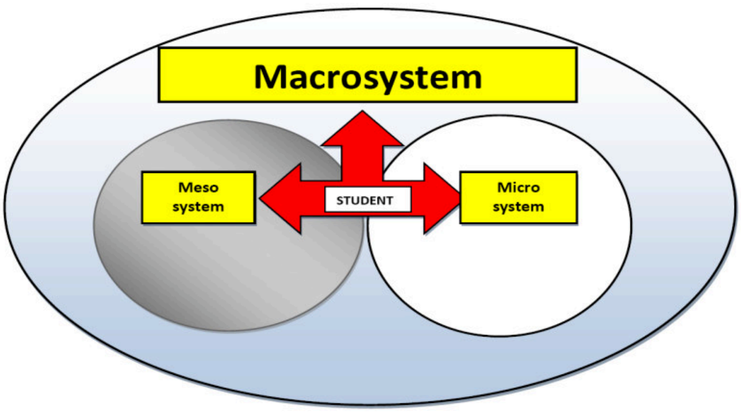


Fig. 9: Conceptual view on Bronfenbrenner's Theory of Human Ecology

Microsystem – The Classroom Environment

The nested-system, most-proximal to students, is the classroom-environment. Multiple-factors, within the engineering-classroom-environment, have been cited as contributing to high-attrition-rates in engineering, including lecture-based pedagogy, norm-referenced-grading (i.e., grading on a curve), and individual-based work (Seymour & Hewitt, 1997; Astin, 1993). In addition to teaching-practices and curriculum, the engineering-classroom-climate, which is often described as "unwelcoming," may also influence attrition (Litzler & Young, 2012; Fitzmorris *et al.,* 2010; ASEE, 2009). A "chilly" classroom-climate has also been cited as a concern for the success of female-students in engineering by Newman (2011); Brown *et al.* (2005); May & Chubin, (2003); and Vogt (2008) found, that students' perceived faculty-distance has a negative impact on engineering-students' self-efficacy and academic-confidence, and an indirect-negative-affect on their performance.

Mesosystem – Co-Curricular Experiences

It was conceptualized, that these at the Mesosystem serve as connections between the classroom and the broader-engineering-community. Engineering-departments are implementing a range of co-curricular experiences, in hope to enhance the educational-process and improve retention and completion-rates, including internships, cooperative-experiences, and research-opportunities (ASEE, 2012). Internships provide students direct-work-experience with an engineering-firm, and cooperative-experiences place students in an engineering-work-environment, for as much as a year or more, as part of their-course requirements for their-degree (Jaeger *et al.,* 2008; Do *et al.,* 2006). At SOE, for example, engineering students (after completing their 3rd and 4th year of study) should carry-out 12weeks of their-compulsory Industrial Attachment. This co-curricular-experience is very-much-appreciated by the students, as it gives them the exposure to real-life industrial-activities and practices, within industries in Kenya, and, even, across East-African neighbouring-countries.

Undergraduate-research-experiences provide an inquiry-based learning-environment, to give students hands-on practical-experience with science and engineering (Kinkead, 2003; Zydney *et al.,* 2002; Freeman, 2000). At SOE, for example, 5th year engineering-students should conduct their-research-project. The project takes the whole-academic-year, with the defence, as a culmination of the degree-program. Results of many successful-projects were disseminated, as publications in reputable scientific journals, and even, in few-patents.

Additionally, many-institutions have implemented targeted-retention-programs, for underrepresented minority-students in engineering and have demonstrated success in improving the retention and persistence rates (ASEE, 2012; Good *et al.,* 2002; Ohland & Zhang, 2002). These-programs, often provide students a sense of community and academic support, within engineering-programs (May& Chubin, 2003). Many institutions also provide financial-assistance, that meets a critical-need for underrepresented-students in engineering (ASEE, 2012; Georges, 2000), and a great-deal of support has been allocated to sustain and enhance these-programs (NAS, 2011; Bennof, 2004).

Macrosystem – Institutional Context and Characteristics

Most-distant from the student-experience is the institutional Macrosystem. Various institutional-level characteristics have been shown to influence degree completion or retention in the STEM fields, including size (Hurtado *et al.,* 2012; Oseguera, 2005), selectivity (Espinosa, 2011; Bowen *et al.,* 2009; Bowen & Bok, 1998), whether the institution is private or public (Espinosa, 2011; Ishitani, 2006; Titus, 2006), and minority-serving-institutions(Crisp *et al.,* 2009) as, for example, in Kenya, Women's only universities are logically regarded as safer environments for female-students. These considerations have recently led to the opening of the Kiriri Women's University for Science and Technology in Nairobi, Kenya; Institutional type, such as research-universities or arts-colleges, has also been shown to have an impact on degree-completion (Astin & Oseguera, 2005), although this-effect may be moderated by race/ethnicity (Oseguera, 2005).

4.3.2. Tinto modelling and selected relevant theories.

Tinto (1975) developed an approach for modeling student drop-out-behavior, that focuses on the quality of interaction, which exists between a student and the higher-education-institution, at which they enroll. More specifically, the individual-attributes of each-student (such as their-underlying ability, race, ethnicity and gender), together with some-family-background-characteristics (such as their parent's level of education) and pre-university schooling-experiences (such as the grades, which they have achieved), help to form a level of initial-motivation, that is then forced to interact with a set of institutional experiences, within the university. Tinto divided these-institutional-experiences into two-distinct-components: (1) an academic component, comprising the academic-performance of the student and their-interaction with faculty or staff members, within the university and (2) a social-component, comprising their extra-curricular-activities and peer-group-interactions. The extent, to which these-forces can successfully integrate with each other, helps to determine whether students persist with their-studies or leave the university, whether leaving is on a voluntary-basis (because they want to enroll at another-institution) or an involuntary-basis (because of their poor-results and subsequent discontinuation on academic-grounds, from the university). When interpreted in this-manner, one deals with a decision-making-process, that fits more-comfortably into a competing risk paradigm, in which a variety of socio-economic-forces are pulling the student towards one or other mutually-exclusive-set of possible-outcomes.

Expectancy theory suggests that lower self-confidence should increase the expected level of effort needed to study engineering. If women generally have lower-levels of confidence, in their engineering-related knowledge and skills, the theory states that they should expect to work-harder to achieve the valued-outcomes. Conversely, if men have higher-levels of confidence, in their engineering-related knowledge and skills, then they should expect less-effort, required to graduate. Expectancy theory closely relates to Cognitive dissonance theory, in the sense that *Cognitive dissonance theory* may explain why women have lower-confidence-levels, yet perform and persist on par with men. The study hypothesize, that greater alignment between expectations and experience—less dissonance—requires less-radical change in the individual. The finding that women perform engineering- tasks equally as well as men and that they persist at equal-rates with men, may, in part, be due to their lowered-confidence at entry. Rather than experiences of disillusionment, females may be more-realistic in the expectations of difficulty, at the outset of the engineering-program. Males had greater-confidence in themselves, going into engineering-education, and, therefore, perhaps, suffered more-disillusionment than women as they experienced academic-challenges in the study.

Environmental theory provides the basis from which to understand the relationship between students and the campus-environment (Alonzo-Zaldivar, 2003). Lane (2002), wrote that student affairs professionals can no longer ignore, or underestimate, the respective-influence of the many on-and-off campus-variables (racial/ethnic climate, religious-practices, and working on or off campus) that concurrently affect student behaviors.

Involvement theory affirms the belief that students learn best and are more likely to persist by becoming involved in the campus-community (Suarez-Orozco & Paez, 2002). Involvement-factors are those variables, that occur within the college-environment, such as (a) student-faculty interaction, (b) the role of the mentorship, and (c) participation in student-organizations. The extent, to which a student is involved on campus, acclimated to the academic-culture of the institution, and connected socially to various components of the university-community (i.e., faculty, administrators, student affairs professionals, and peer groups) has shown to be a reasonably-strong-predictor of student-retention (Pascarella & Terenzini, 2005; Tinto, 1999). Students, who are committed to their-institutions, are more-likely to persist and graduate (Tinto, 1999).

Personal-factors (background-characteristics or pre-college-variables) are also useful in understanding how students adjust to college (Hurtado, 2000). They include high-grade-point-average and test-scores, academic-self-concept, family-support, finances, academic-under-preparedness, first-generation-status, language-issues, low-income-background, other-family- demands, and cultural-adjustment.

4.3.3. Academic, non-academic and other-factors of influence.

Non-academic factors, typically assessed once the student is enrolled, can also affect retention (Mangold *et al.,* 2003; Braxton & McClendon, 2002; O'Brien & Shedd, 2001; Kennedy *et al.,* 2000; Wyckoff, 1998). Non-Academic Factors include**:** Academic-goals (Level of commitment to obtain a college-degree), Achievement-motivation (Level of motivation to achieve success), Academic self-confidence (Level of academic self-confidence (of being successful in the academic-environment)), Academic-related-skills (Time-management-skills, study-skills, and study-habits (taking notes, meeting deadlines, using information-resources)), Contextual-influences (The extent to which students receive financial-aid, institution-size and selectivity), General self-concept (Level of self-confidence and self-esteem), Institutional-commitment (Level of confidence in and satisfaction with institutional-choice), Social-support (Level of social-support a student feels that the institution provides), and Social-involvement (Extent to which a student feels connected to the college-environment, peers, faculty, and others in college, and is involved in campus-activities).

First generation status: According to Starovoytova & Cherotich (2016 b), 42 % of the students enrolled at SOE, MU in the period between 2003 and 2014 were the first-generation to do so in their-families. Such families (from where students came from), normally, are unable to support the students academically (Makuakane-Drechsel & Hagedorn, 2000). Rendon *et. al*. (2000), state that first-generation-status is characteristic of many-students, who have difficulty transitioning and adjusting to university-studies.

Low-income background: Students with such background face financial-struggles to pay for college tuition, books, and fees, and because they cannot afford to live on campus, spend a great-deal of time commuting from home. For these-reasons, the students are deemed at risk of attrition from college (Yeh, 2004). Students having financial-problems, who need to work may be at a greater-risk of dropping out of college, than those who are more financially-secure. For example, Ishitani & DesJardins (2002), found that students who receive financial-aid, generally, have lower-drop-out- rates, than non-aided students.

According to World Bank (2015) estimation, Kenya's poverty level stands at 44-46%, meaning that 54-56% of the population live below poverty-line. At SOE, for example, students coming from families with low-income background are usually had to opt staying at a small-village about 2 km from the campus, just to save some-money on accommodation. This, consequently, could affect their-performance and retention, as in contract to campus-environment, electricity, water and security cannot be guaranteed in the village, which directly-interferes with students' ability to study.

Academic Factors: In Kenya, for example, it is revealed as KCSE examination-results (university preparedness measure in English, Mathematics, and Science), and also as cut-off points (for Kenya Universities and Colleges Central Placement Service (KUCCPS)).

There are also *other factors*, such as **s**ocio-economic status (SES), includes parents' educational attainment and family-income, and socio-cultural-factors are "multiple-forces, which can shape the personal and environmental-experiences of students and include various-aspects of identity development" (Hernandez & Lopez, 2004). These socio-cultural-factors include: (a) immigrant-status, (b) ethnic-identity, (c) gender-roles, (d) community-orientation, and (e) the role of religion. Other-family-demands can also affect the performance, persistence and retention. In Kenya, for illustration, due to high-prevalence of HIV/AIDS (8.6% of the population), many-students are orphans; who, time and again, have to work, in parallel to their-studies, to support younger-siblings, and also take care of household-duties. According to Kuh& Love (2000), these-students spend most of their non-class-time operating in their-culture of origin, which reduces their-likelihood of persistence.

5. Conclusions and Recommendations

It's conspicuous that women accounted for a relatively-low-fraction of the degrees-awarded in SOE, MU, accounting on average for only around 13 % of the total-number of engineering-graduates. However, in this study, which was focused, first and foremost, on analysis of the graduation-outcomes; female undergraduate engineering-students, although heavily- underrepresented, performed as well as, and, in some instances, even better, than their male-counterparts. The causes of the observed gender-differences in performance and attitudes, as highlighted before, are a complex-web of inter-related-issues. Some undoubtedly have to do with attitudes and prejudice acquired prior to university (e.g. negative-beliefs held by both women and men about women's suitability for technical-subjects); some involve differences in priorities and goals (e.g. different relative priorities placed by men and women on personal relationships and class-work); others involve academic and non-academic-factors. Although the exact-reasons for this finding were not identified (being outside the scope of this-concise-study); any combination of factors, discussed earlier, might be accountable. Further research, therefore, is in order, to investigate the individual-and institutional-level factors, which jointly predict students' likelihood of completing a bachelor's degree in engineering. The question:"What factors have, according to you, the most important influence on your academic performance and completion of your program at the university?" should be surveyed from both male and female students', to assess their-perceptions and experiences in engineering-studies (to get the valued information "from the horse's mouth").

It important to note, that caution should be exercised in generalizing the results from this-study, as the underlying samples are from one engineering school/university. This, however, does not undermine the findings of the study. Logically, to broaden the horizon, further-researches should sample more universities in similar-studies.

The study, in addition, made following-specific (departmental and school-level) recommendations:

1. An integrated-approach in the retention efforts should be initiated, starting at engineering-school-level. The approach should incorporate both, academic and non-academic factors, into the design and development of programs to create a socially-inclusive, supportive and safe-academic-environment that addresses the social, emotional, and academic-needs of students of both sexes; males and females.
2. An early alert, assessment, and monitoring-system of students, at risk of dropping out, should be set off at the departmental-level. The system is mainly based on continuous assessment tests (CATs) results and attendance records. In case of worryingly-low-performance and poor-attendance of classes, of a particular-student, this should be reported to Head of Department, to necessitate further-inquiry on socio-economic-information and non-academic-information on the student. The information will assist to identify and build comprehensive-profiles of students at risk. Intervention-strategies should also be designed (with respect to types of interventions required—academic and non-academic) including remediation, cancelling, tutoring, and providing extra-tutorials and financial-support, among others, to affected students.
3. The economic-impact of the time to degree completion-rates, through a cost-benefit analysis of students drop-out, should be determined.

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